

CERES Science Team Meeting

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Marriott Hotel

City Center at Oyster Point, Newport News VA

The NPOESS Preparatory Project (NPP) Science Data Segment: A Brief Overview

By

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Science Data Segment Introduction

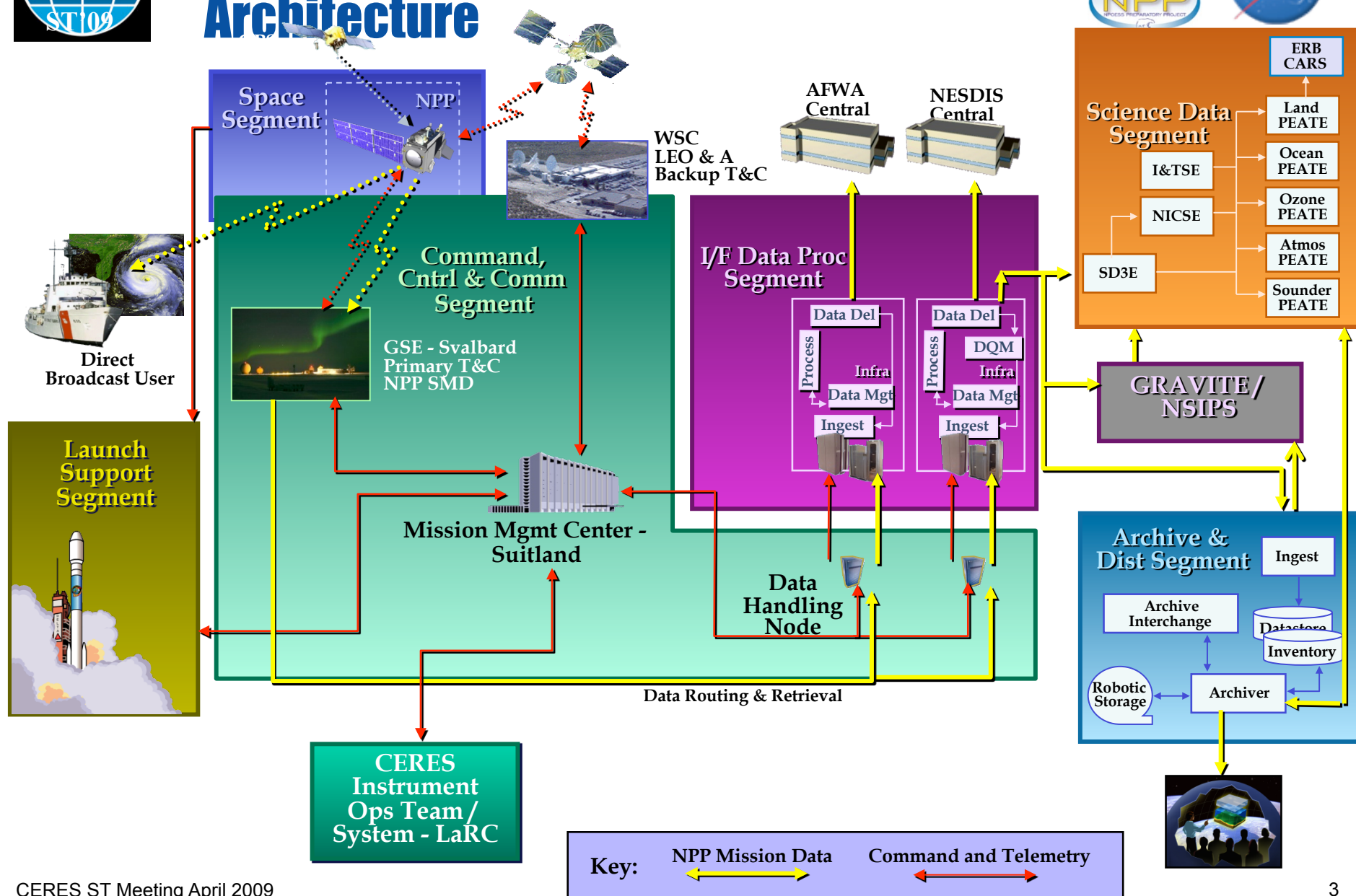


- **Measurement-Based Processing Concept**
 - Discipline based groups are selected to Assess or Generate Measurements
- **SDS' Primary Charter is to assess the quality of the NPP Environmental Data Records for their ability to support Climate Research**
 - **Five** Product Evaluation & Analysis Tool Element (PEATEs)
 - Ocean, Land, Atmosphere, Ozone, and Sounder
 - **One** Climate Research Analysis System (CARS)
 - Earth Radiation Budget

In developing the SDS, the Project assumes that EDRs produced by the NPP Program are climate quality and put in place the capability to test that hypothesis in order to contribute to improving the quality of future EDRs.



NPP Mission System Architecture





SDS Purpose



- ***The NPP Science Data Segment is a System of Systems distributed amongst: 9 facilities located at GSFC, JPL, Univ. of Wisconsin, & LaRC***
- ***The SDS is responsible for:***
 - *Serving as a prototype element for the future NASA Earth Science Enterprise (ESE) science data systems*
 - *Assessing NPP Environmental Data Records (EDRs) for climate quality suitability*
 - *Providing & Demonstrating SDR & EDR algorithm improvements / enhancements*
 - *Supporting Calibration / Validation Activities in processing selected data*
 - *Producing Research OMPS Limb SDR & EDR, performing OMPS Limb Instrument Calibration Management, & Instrument commanding*
 - *Producing CERES climate quality data records for characterization of global climate change*

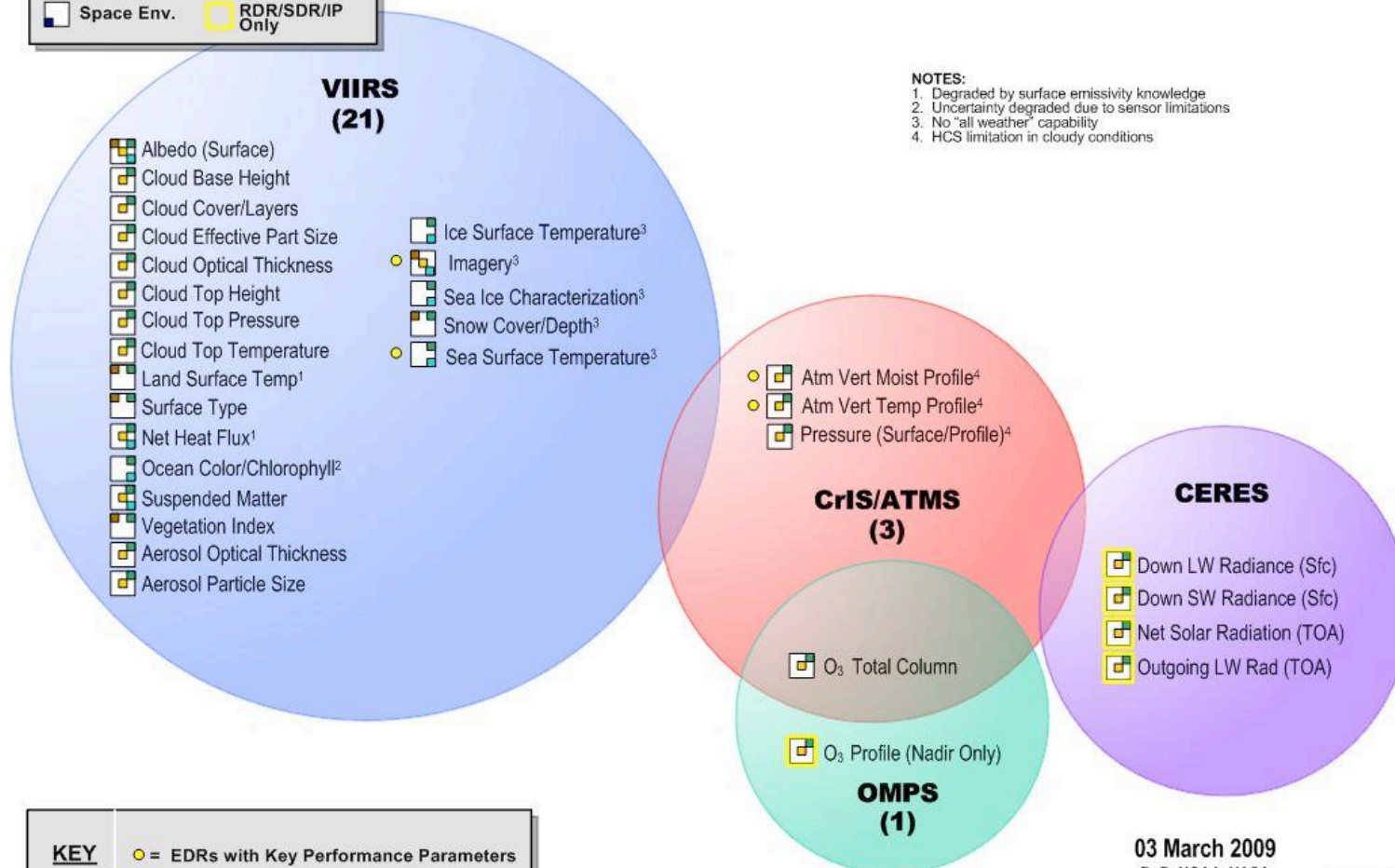
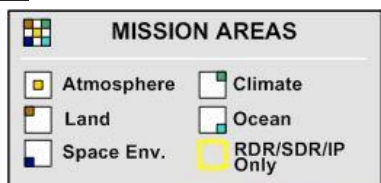
SDS is a Research Tool that supports the NPP Science Team Members



NPP Products



NASA/NPOESS NPP – 25 IORD EDRs



NOTES:
 1. Degraded by surface emissivity knowledge
 2. Uncertainty degraded due to sensor limitations
 3. No "all weather" capability
 4. HCS limitation in cloudy conditions

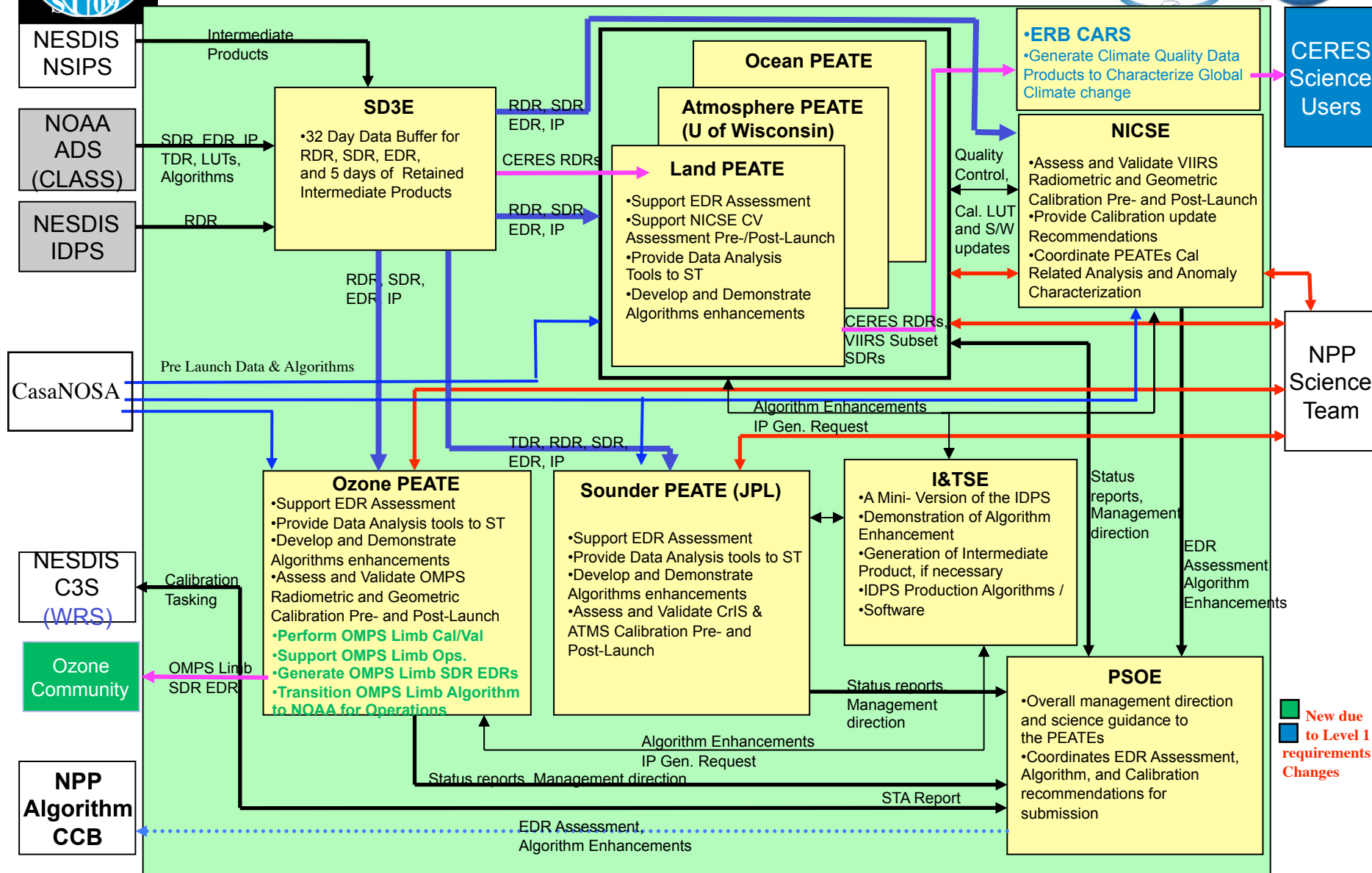
EDRs not delivered by NPOESS are not counted in totals
 Each sensor produces a unique product in overlap regions

03 March 2009
 DoD, NOAA, NASA,
 Integrated Program Office
 M. Haas, F. Eastman
 G. Mineart, J. Whitcomb

**NPP
V17**



SDS Logical Block Diagram (1 of 3)





SDS Logical Block Diagram (2 of 3)



- **SDS Data Delivery & Depository Element (SD3E), NASA GSFC Code 586/614**
 - *In-House development effort. Some software reuse from MODAPS. Provides ~32 days “rolling storage” for pick-up by PEATEs and the NICSE. Serves as front-end between the providers, ADS/CLASS, IDPS, & NSIPS, and the SDS Elements*
- **Land Product Evaluation Analysis Tool Element (PEATE), NASA GSFC Code 614**
 - *Developing & integrating NPPDAPS by reusing MODIS Adaptive Processing System (MODAPS) and integrating with the Level 1 Atmosphere Archive and Distribution System (LAADS)*
- **Atmosphere PEATE, University of Wisconsin-Madison**
 - *Developed & integrated SPS for data staging, data management, and algorithm rules application*
- **Ocean PEATE Climate Analysis Research System, NASA GSFC Code 614**
 - *Added System Capacity to existing Ocean Data Processing System (ODPS). Requires I&TSE for EDR Production Algorithm analysis*
- **Ozone PEATE, NASA GSFC Code 614**
 - *Adding capacity to Atmospheric Composition Processing System (ACPS), formerly known as OMIDAPS to capture Ozone xDRs for analysis and evaluation*
 - *Recently allocated requirements for Producing Research OMPS Limb SDR & EDR, performing OMPS Limb Instrument Calibration Management, & Instrument commanding*



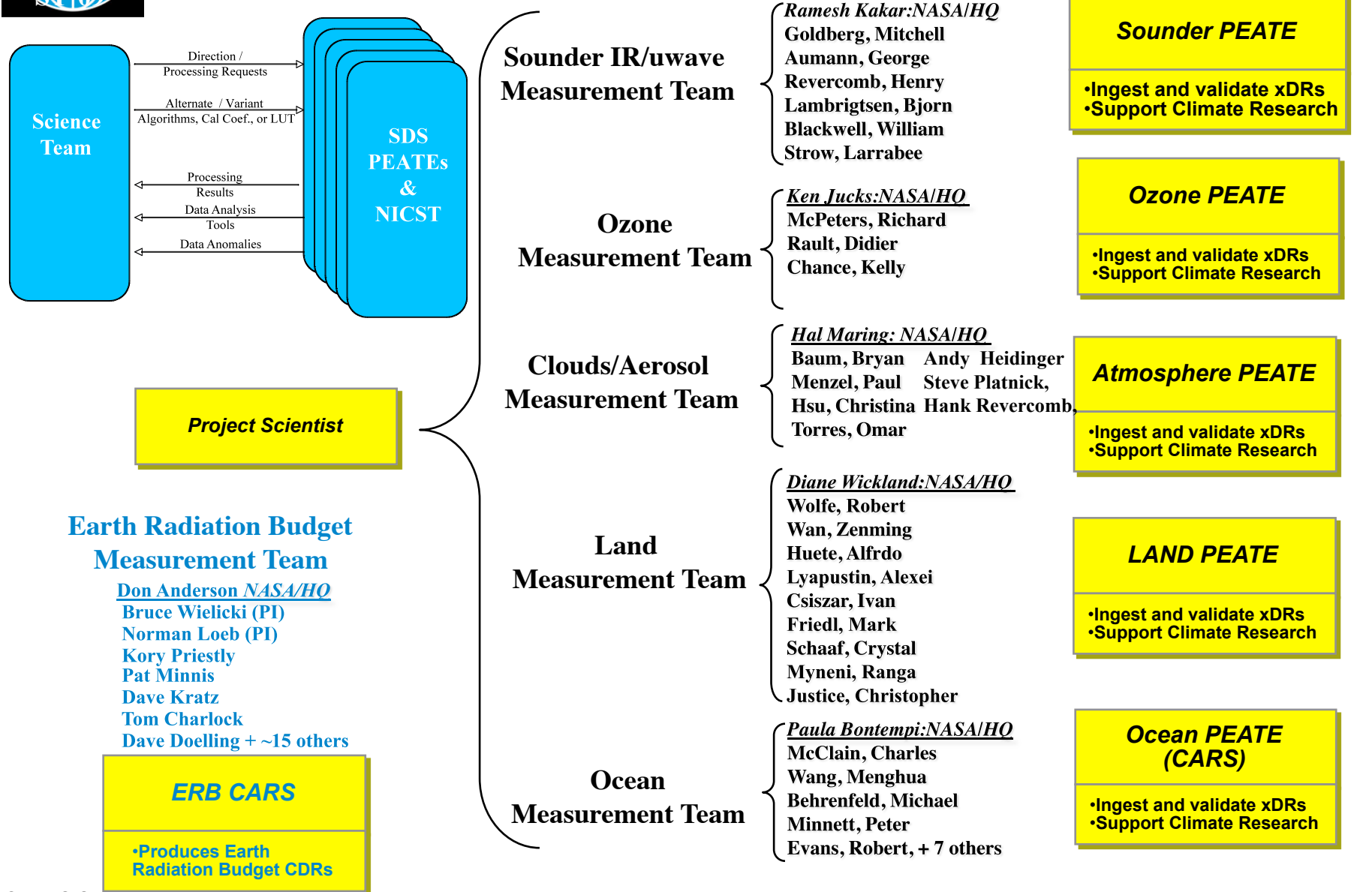
SDS Logical Block Diagram (3 of 3)



- **Sounder PEATE, NASA JPL, Pasadena, CA**
 - Adding capacity to the Atmospheric Infrared Sounder (AIRS) Project's Team Leader Science Computing Facility (TLSCF) for assessing climate quality of Atmospheric EDRs. Also assess and validates CrIS and ATMS Calibration.
- **Earth Radiation Budget Climate Analysis Research System (ERB CARS) NASA LaRC**
 - Leverages existing processing capabilities and human resources across the Atmospheric Science Data Center (ASDC), CERES Science Group, and the Data Management Group at the NASA Langley Research Center for characterization of Global Climate Change & Climate Data Record Production
- **Integration and Test System Element (I&TSE) NASA GSFC Code 586**
 - A smaller scale clone of the production IDPS System. Affords PEATES ability to: analyze production algorithms, trouble shoot processing chains, regenerate Intermediate products and to demonstrate algorithm enhancements and / or calibration improvements
- **NPP Instrument Calibration Support Element (NICSE) NASA GSFC Code 600**
 - Leverages MODIS Calibration Support Team and NPP/VIIRS Science Teams Members for the assessment and characterization of the radiometric and geometric performance of the VIIRS Instrument
- **PSOE - Project Science Office Element NASA GSFC Code 613.3**
 - Tool to be used by the NPP Project Scientist. Coordinates data analysis priorities, algorithm enhancement, Look Up Table (LUT), and calibration coefficient changes with PEATES/NICSE. Web based open source tools to track requests, generate notifications, and data issues. Used to submit algorithm and calibration recommendations to NPP/NPOESS Algorithm Configuration Control Board.



SDS PEATE to Science Teams





Roles and Responsibilities Science Team - PEATE Generic



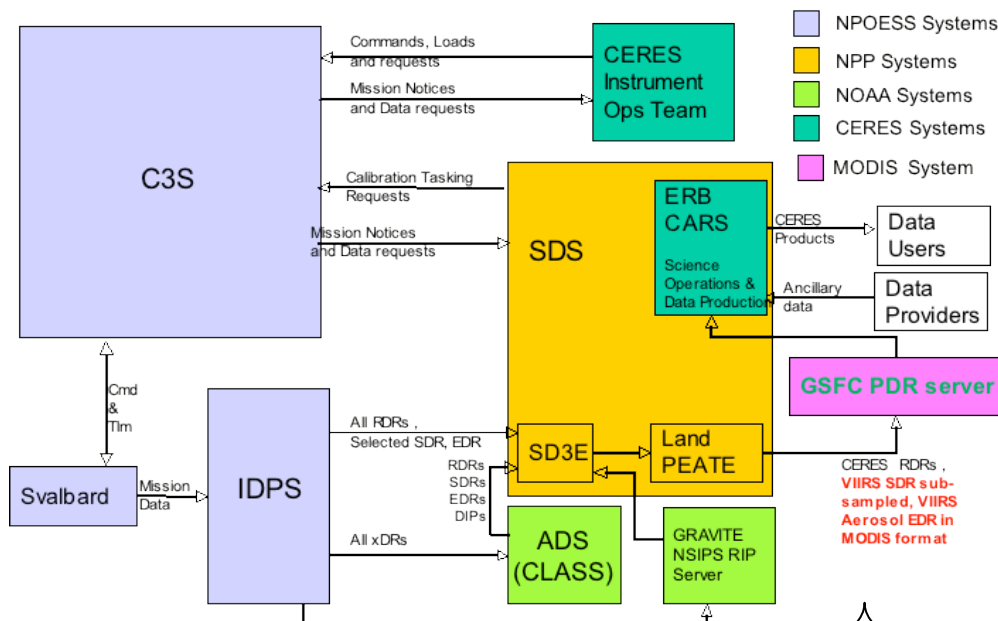
Science Team	PEATE
<p>Perform simulations & studies with algorithms</p>	<p>Integrate, wrap, or port, NPP Production Algorithms</p>
<p>Compare performance of production algorithms with that of heritage algorithms.</p>	<p>Integrate heritage algorithms as requested by Science Team</p>
<p>Design / Direct Software tools needed (e.g., software to evaluate SDR.)</p>	<p>Stage heritage data as needed</p>
<p>Validate results, suggest calibration adjustments, & algorithm improvements</p>	<p>Implement & demonstrate improved algorithms</p>
<p>Coordinate and Provide feedback to Project Scientist</p>	<p>Interface with SD3E, ADS/CLASS, I&TSE, & C3S Extranet server as needed.</p>
	<p>Implement xDR Acquisition, Cataloging, and Management</p>
	<p>Implement/Adapt Product Evaluation Software Tools</p>



SDS to ERB CARS



Land PEATE to ERB CARS Interface

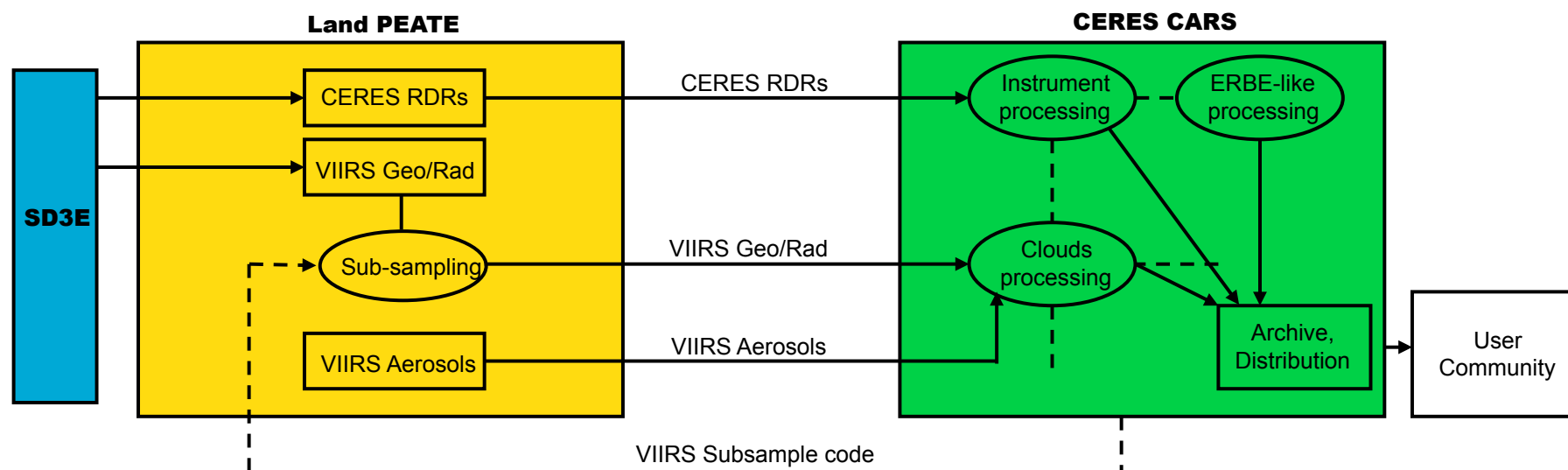


• SIPS Interface

- ASDC will implement EOSDIS SIPS PDR-PAN interface in their new system (ANGe).
- Products will be placed in a disk partition reserved for NPP CERES on the MODIS PDR server located at GSFC
- ASDC will transfer products from this directory using SIPS protocol.



CERES Data Sources



- 1- The Land PEATE receives CERES RDRs and VIIRS xDRs from the SD3E.
- 2- CERES RDRs are passed directly to the CERES CARS, where they are processed by the Instrument subsystem to produce inputs to the ERBE-like and Cloud subsystems.
- 3- The Land PEATE produces MODIS-like VIIRS radiance/geolocation and aerosol files.
- 4- The Land PEATE sub-samples the MODIS-like VIIRS radiance/geolocation data using software provided by CERES.
- 5- The Land PEATE sends the sub-sampled VIIRS files and the MODIS-like VIIRS aerosol files to the CERES CARS.
- 6- The CERES CARS runs the downstream subsystems, beginning with Clouds, as data becomes available.
- 7- Climate-quality data products are archived and made available to the user community along with Data Quality Summaries and user support.



Land PEATE Operations Concept for Reprocessing for CERES



- **During 2 years of VIIRS post-launch product evaluation**
 - VIIRS Algorithm and Calibration improvements will be developed by the VIIRS Science Team members
 - NICSE and Land PEATE will facilitate and demonstrate improvements
 - Results of these evaluations will be shared via Land PEATE and ST web sites.
- **CERES Science Team will determine versions of VIIRS SDR (L1B), Aerosol EDR, and VIIRS Calibration to use in reprocessing**
 - Land PEATE resources will be dedicated for reprocessing products.
 - Reprocessing will proceed from earliest well calibrated scene to present using best available calibration.
 - Reprocessing throughput is planned for ~3x
- **ASDC handles reprocessing of CERES Climate Data Records (CDR)**



Status of LAND PEATE development for CERES



- **Proxy data generator (extended SDRgen) running in Land PEATE produces VIIRS SDR (MODIS bands with VIIRS geometry).***
- **16-days of proxy SDRs has been produced to test code integrated from IDPS Build 1.5.0.15.1**
 - Cloud Mask, Active Fires, Aerosol Optical Thickness, Surface Reflectance and Vegetation Indices
 - Geolocation problem in Build 1.5.0.15.1 fixed in current delivery 1.5.0.25.2 .
 - Aerosol calculations use 6x6 elements not 8x8
- **Additional days of proxy SDRs will be generated for CERES in October**
- * CERES requested simulated day/night band be added and that modification will complete testing by 10/1/08



NPP Instrument Calibration Support Element (NICSE)



Purpose of NICSE



- **Develop or adapt MODIS tools and techniques for Independent evaluation of the Radiometric and Spatial Geometric Performance of the VIIRS Instrument**
- **Provide calibration support to the VIIRS PEATEs and Science Team**
- **Recommend VIIRS Sensor Data Record (SDR) improvements to the Project Scientist (Project Science Office Element (PSOE))**
 - VIIRS SDR Algorithms and/or Look-Up Tables (LUTs)
- **For CERES: generate consistent set of calibration LUTs for the VIIRS SDR production (i.e., L1B)**
 - The Land PEATE will use the revised LUTs to generate a CDR-quality VIIRS product for CERES

Check out the NICSE poster for more details!



NICSE is built on a series of software tools and the analysts to run them



Completion Date	Radiometry Tools
11/01/08	LUT update tool
12/01/08	Planner for Lunar view
09/01/09	Planner for SD/SDSM calibration
02/01/09	OBC-IP reader tool
02/01/09	SDR and vRDR reader tool
08/01/09	Spacecraft telemetry RDR reader tool
05/01/09	Solar Diffuser calibration for RSB
05/01/09	SDSM degradation for Solar Diffuser
07/01/09	RSB response trending
10/01/09	RSB radiometric stability using the moon
01/01/10	RSB RVS: EV DN vs. AOI & HAM side ratio
05/01/09	BB warm-up calibration for TEB
07/01/09	TEB response trending
10/01/10	TEB RVS: Deep Space Maneuver
09/01/09	DN trending for SV, BB, and SD over time
08/01/09	VIIRS telemetry trending
10/01/10	DN saturation trending
07/01/10	ADC performance trending
01/01/11	Band to band registration trending using the moon
10/01/10	Xtalk evaluation using the moon
01/01/11	Mirror-side noise pattern trending
04/01/10	Visualization and statistics tool for EV data
06/01/09	SDR validation tool

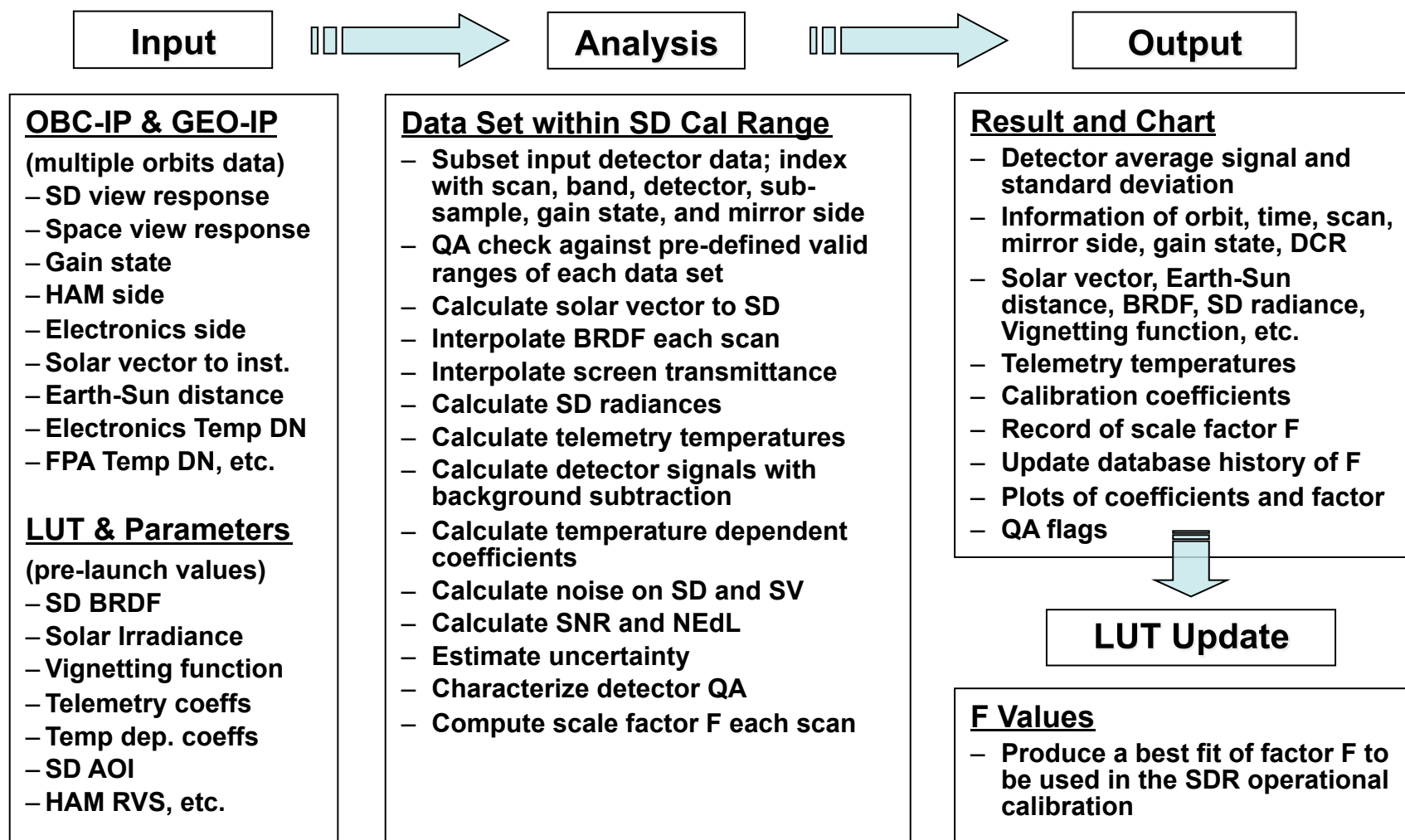
Completion Date	Geometry Tools
01/01/09	Control Point Matching. The output are CP residual files.
01/01/09	Merge many CP residual files into one file containing the combined data
01/01/09	CP Residual statistical analyses based on scan angle and mirror sides
08/01/09	Error Analysis Program
01/01/10	Long-term Trending Analysis Program
10/01/09	CP Chip Generation
01/01/10	CP Chip modification/utilities
04/01/10	Band to Band Spatial Shift Assessment
04/01/10	Artifact Visualization and Gridding Tools

Analysis Techniques:

- Ingest Raw Data Records (RDR) and Intermediate Products (IP)
- Extracts science and telemetry data needed to run Geo and Rad tools
- Runs the tools, performs trending and analysis
- Generates revised cal parameters LUTs and generates SDRs
- Makes recommendations on revisions to LUTs and SDR code



Example of VIIRS Post-Launch Radiometric Analysis Flow: Solar Diffuser Calibration

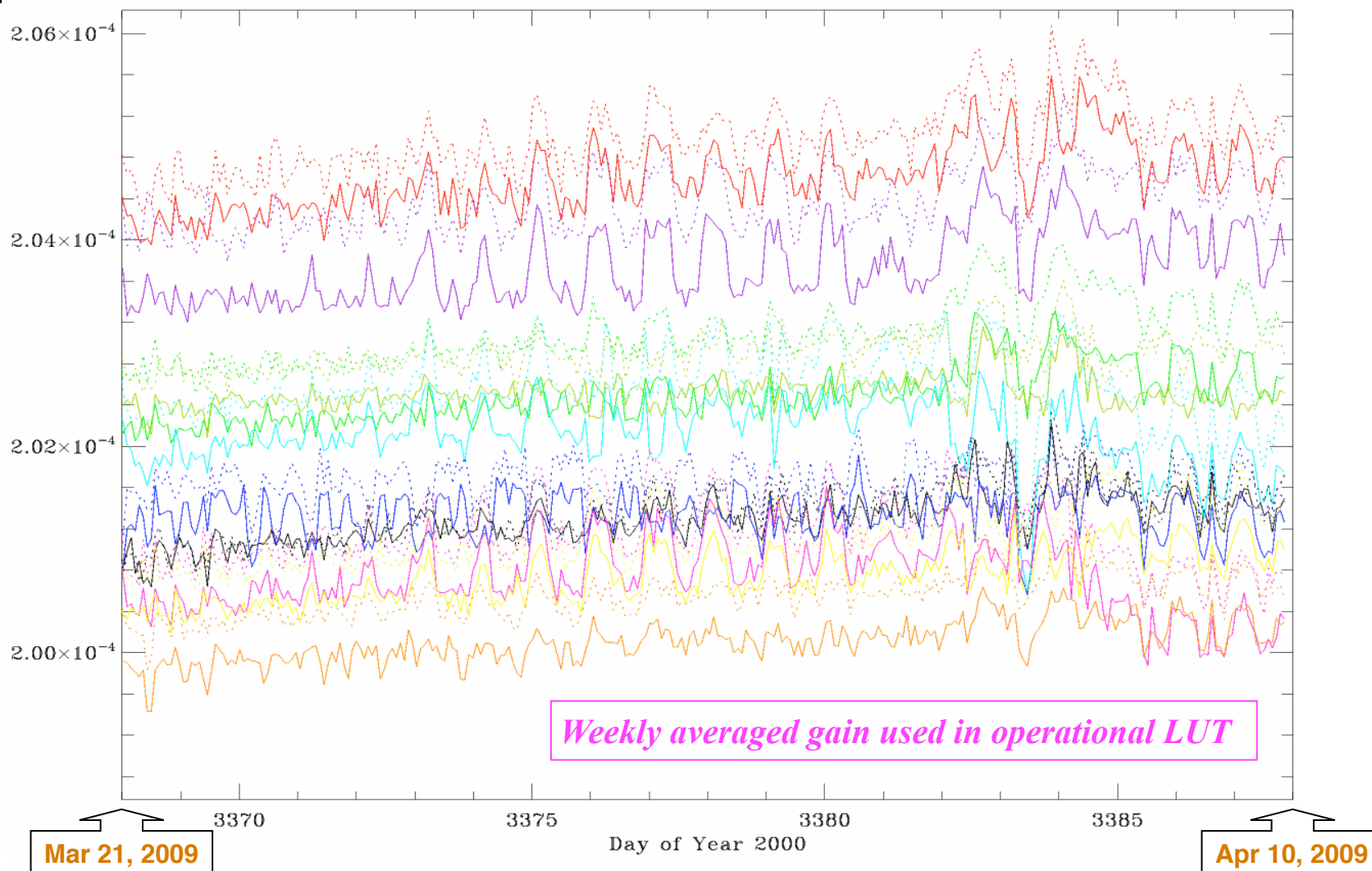


Radiometric Analysis Flows include Absolute and Relative Radiometric Calibration using Internal Calibrator, Deep Space View, and Lunar View, and Radiometric Response and Detector Operability,



On-orbit MODIS Daily Trending – *Linear Gain Calibration*

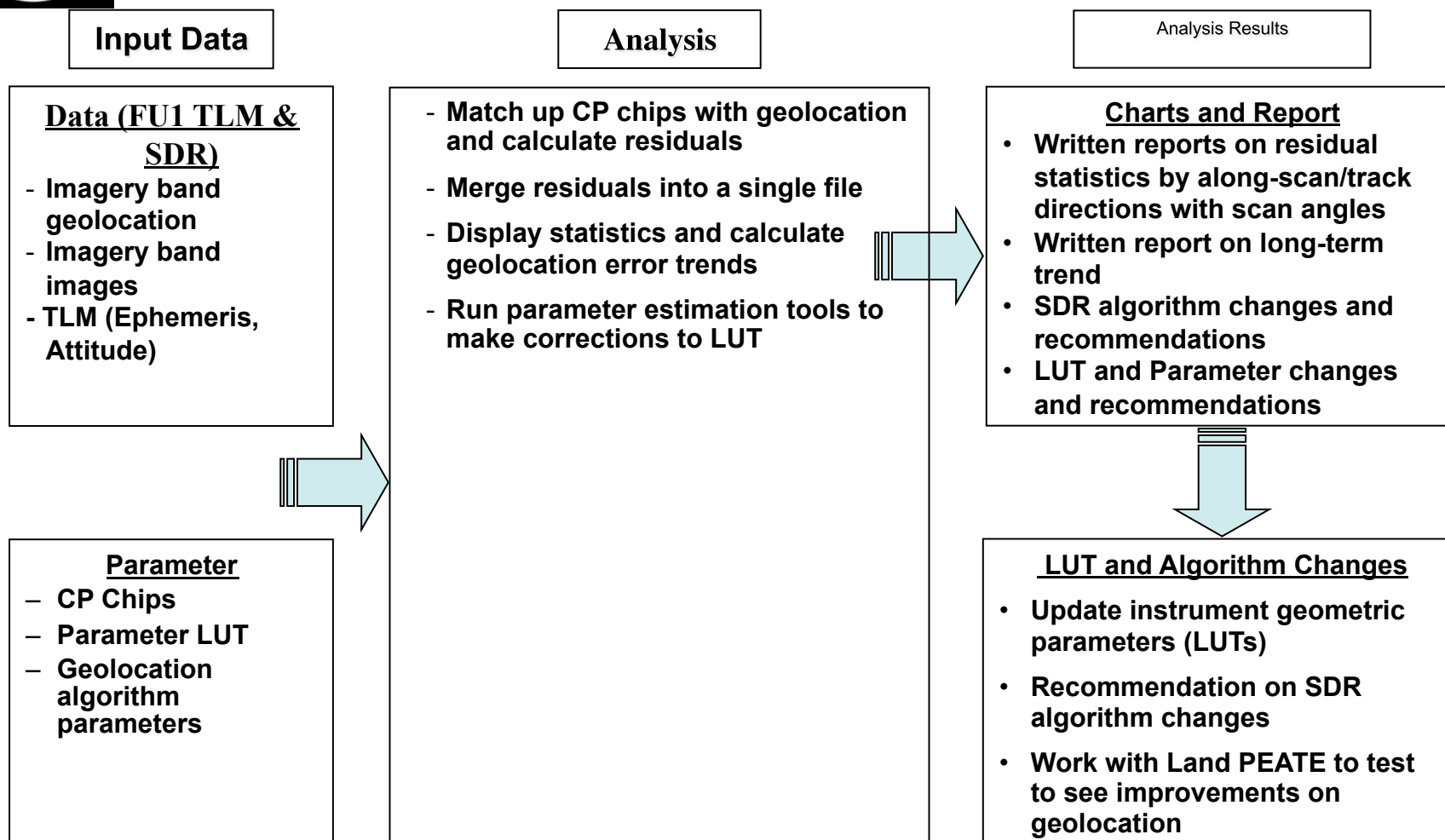
20-Day Terra MODIS Band 26, Ch 1-10, Orbital Trending Using SD
MODIS B26 ($\lambda = 1.36\mu\text{m}$) \equiv VIIRS M9 ($\lambda = 1.38\mu\text{m}$, single gain)



Radiometric Analysis results are recommended LUT and/or Operational Code updates



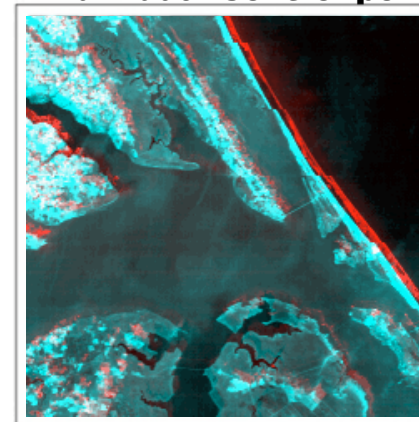
Example of VIIRS Post-Launch Geometric Analysis Flow: Control Point Matching



Geometric Analysis Flows include assessing Geo-location Accuracy Using Ground Control Point (GCP) Residuals, Instrument's Field Angle Knowledge, Scan Profiles, and Band-to-band Registration, and Alignment Between Satellite Navigation Base Reference and the Instrument Line of Sight



Individual control point

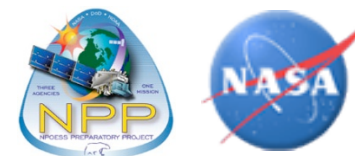


Geolocation Long-term Trend (MODIS Terra)

CERES ST Meeting April 2009



SDS Historical Milestones



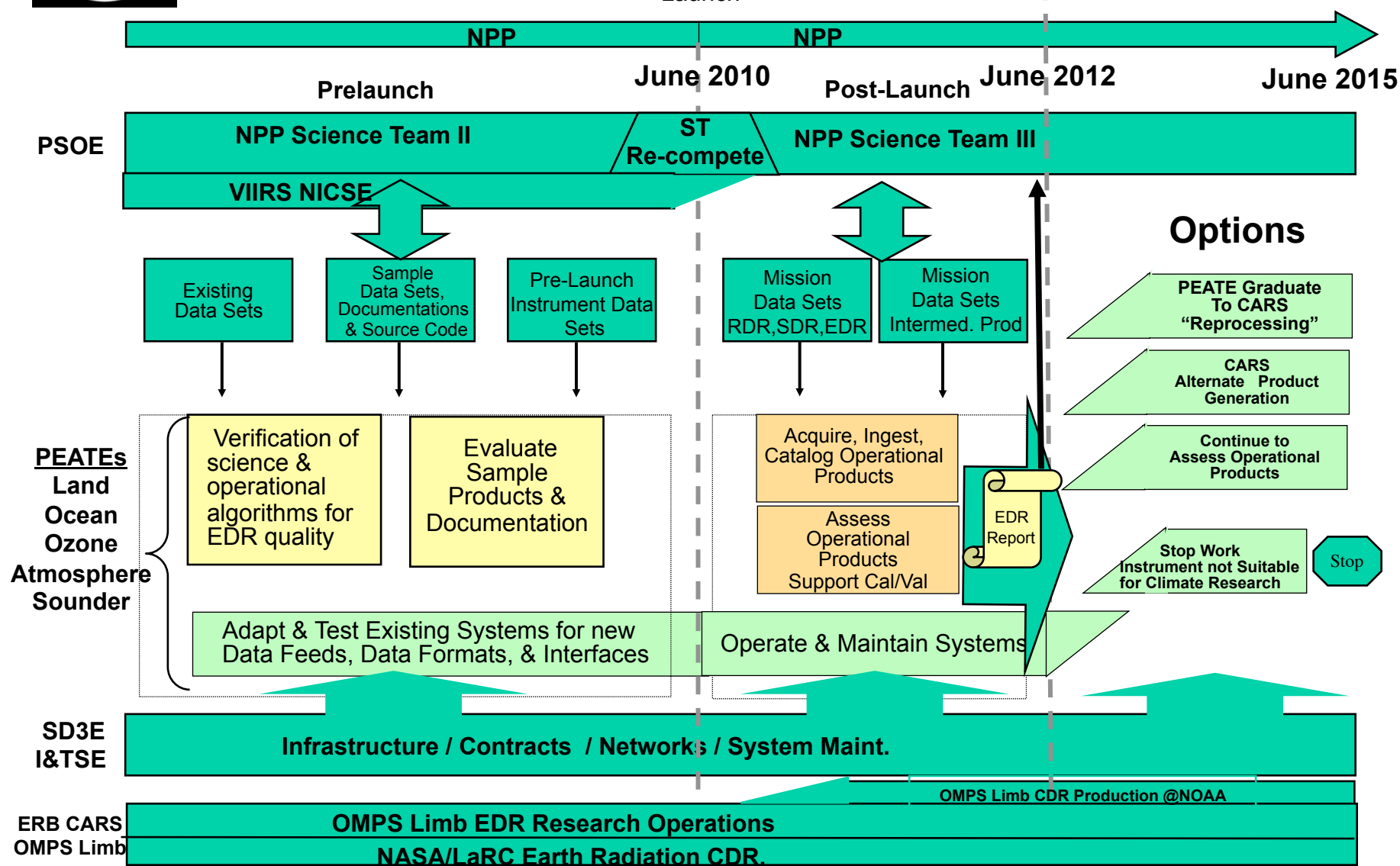
		<u>Launch Readiness Date at Milestone</u>
Feb 6, '01	NPP SDS SRR	10/2006
Aug 26, '03	NPP Confirmation Readiness Review	10/2006
Oct 28, '03	Signed Level 1 NPP Requirements	10/2006
April 28, '04	SDS Steering Committee Meeting @ HQ	10/2006
June 23, '04	NPP SDS Approach Confirmation Review	10/2006
Oct 1, '04	NPP SDS SRR Reloaded	10/2006
April 21, '05	NPP SDS SRR Take 3	8/2008
Aug 15-17, '05	NPP Pre-MOR	8/2008
Fall 2005	NPP SDS Peer Design Reviews	8/2008
Sept 19, '06	NPP SDS PDR	9/2009
Oct 31 - Nov 1, '07	NPP SDS CDR	9/2009
Jan 16, '08	CERES & Limb added Launch Delay Approved	6/2010
June 5 '08	Ozone PEATE, OMPS Limb Delta Design Review	6/2010
June 9, '08	Atmosphere PEATE, CDR	6/2010
Aug. 26, '08	NPP SDS dCDR for CERES	6/2010
Aug. 27-28, '08	SDS Peer MOR, All Elements	6/2010
Oct. 7, '08	Peer Security MOR, SDS Supported	6/2010
Nov 18-20, '08	NPP MOR	6/2010
Feb 2009	Program Monthly Review (PMR)	1/2011



NPP SDS Way Forward (Notional)



NPP
Launch





SDS Pre and Post Launch Activities



- **Pre-Launch**

- Acquire, adapt and integrate science and operational SDR and EDR software into processing Systems
- Adapt existing systems to acquire and evaluate NPP products
- Perform functional testing of operational code
- Acquire and manage various preflight instrument characterization data sets for the Science Team
- Support Interface Confidence Tests, Functional Thread Tests, and NPP Compatibility Tests
- Support (as needed) generation of test data sets for software and algorithm testing
- Support (as needed) data format reviews and various design preparations reviews

- **Post-Launch**

- Nominally, acquire all RDRs, selected SDRs, EDRs and associated ancillary data
- Process selected RDRs to SDRs and SDRs to EDRs as directed by the ST
 - using adapted or wrapped operational software
 - using alternative calibration or LUTs
 - using improved algorithms
- Support browse and distribution of locally generated xDRs to ST
- Perform match-ups and evaluation of EDRs with other mission and In situ data, e.g., MODIS, SeaBASS
- Support SDR evaluation for long-term stability
- Produce “*Research-Grade*” OMPS Limb SDR & EDR. Manage OMPS Limb calibration & submit Limb command Tables for Mission Life.
- Produce CERES Instrument Climate Data Records & Instrument Operations*. Maintain CERES instrument calibration.

*CERES command Requirements are not part of SDS scope



Conclusion



- **The NPP SDS Measurement Based Processing Model marks a change from mission-centric approach**
 - The NPP SDS leverages off of existing data processing centers
 - Using the resources of existing systems
 - eliminates the need to build entire data systems from scratch
 - affords the program the ability to tap the expertise of the science investigators
 - reducing system startup and development costs



Backup Slides



SDS Assigned Measurements



- **LAND PEATE**

1. Albedo (Surface)
2. Land Surface Temperature
3. Snow Cover and Depth
4. Surface Type
5. Active Fires
6. Ice Surface Temp.
7. Vegetation Index

- **Ocean PEATE**

10. Ocean Color/Chlorophyll
11. Sea Surface Temperature

- **Ozone PEATE**

12. Ozone Total Column/Profile
- 12.5 Ozone Limb SDR / EDR**

- **Atmosphere PEATE**

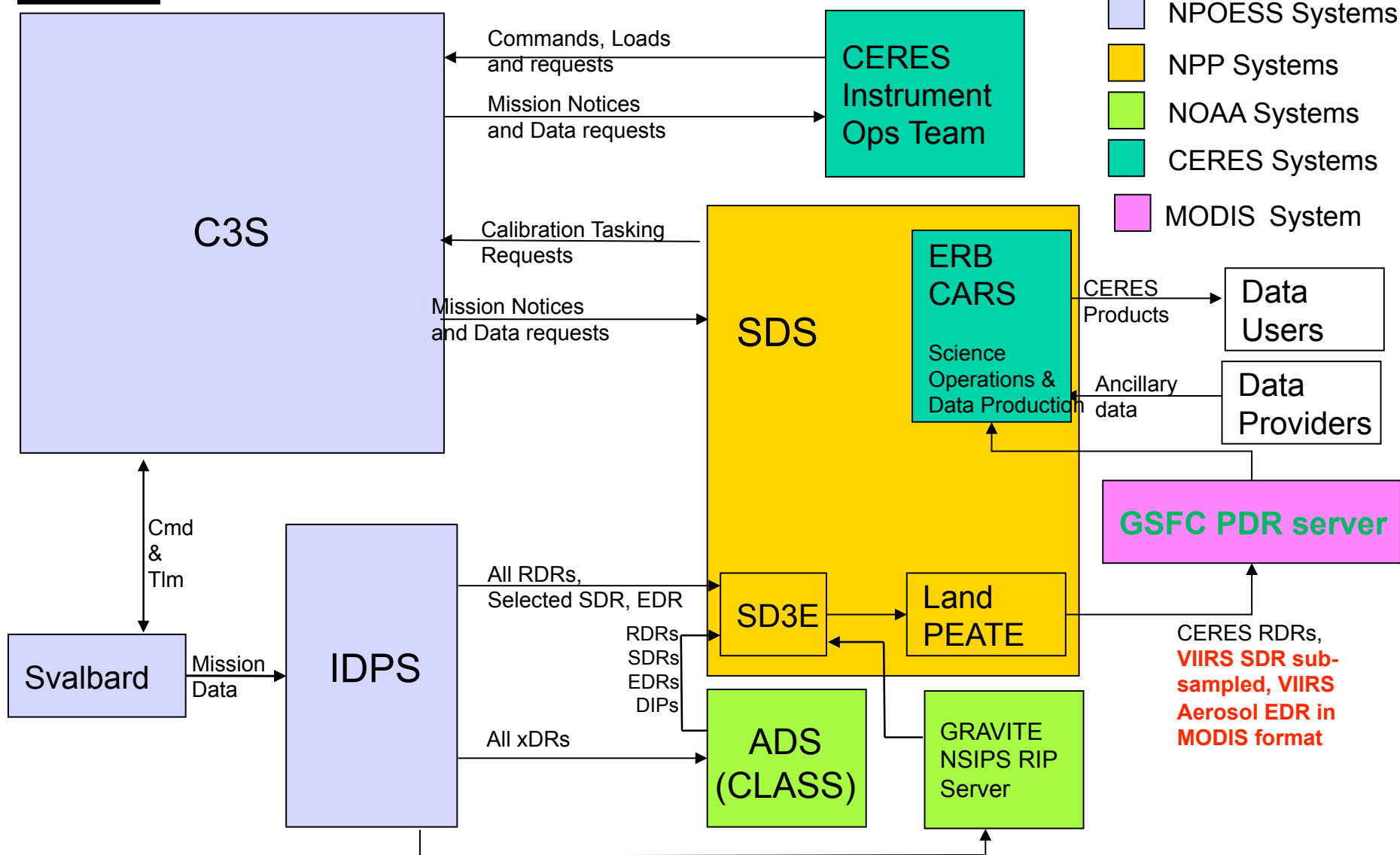
13. Suspended Matter
14. Cloud Cover/Layers
15. Cloud Effective Particle Size
16. Cloud Top Height
17. Cloud Top Pressure
18. Cloud Top Temperature
19. Cloud Base Height
20. Cloud Optical Thickness
8. Aerosol Optical Thickness
9. Aerosol Particle Size

- **Sounder PEATE**

21. Atmospheric Vertical Moisture Profile
22. Atmospheric Vertical Temperature & Pressure Profiles



CERES Operational Data Flow



- NPOESS Systems
- NPP Systems
- NOAA Systems
- CERES Systems
- MODIS System